ERADICATING TALL LARKSPUR ON CATTLE RANGES IN THE NATIONAL FORESTS

A. E. ALDOUS
Grazing Examiner

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HENRY S. GRAVES, Forester

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POISONING by tall larkspur causes heavy losses of cattle in the National Forests each year. During the last three years 5,500 head of cattle were lost annually. The most effective way to prevent this loss is to grub out the plants, a method of eradication which gives permanent results; other expedients are likely to be temporary.

The average cost of eradicating larkspur by grubbing probably falls between $3.65 and $4.15 per acre on range that is comparatively free from rocks, willows, and brush. For willow and rocky areas about $10 an acre probably represents the maximum cost.

Results of grubbing work in National Forest ranges, together with the methods of operation, the tools to use, the best time to do the work, and the best way to dispose of the grubbed plants, are given in the following pages.

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CONTENTS.

LOSSES OF CATTLE FROM LARKSPUR POISONING.

AT LEAST 5,500 head of cattle have been lost yearly during the last three years from poisonous plants on ranges within the National Forests. The value of the stock lost annually is approximately $300,000. Usually the heavy losses occur on comparatively small portions of the forest ranges. Several plants are responsible, but about 90 per cent of the loss can be charged to tall larkspur.

Special effort has been made by the Forest Service in cooperation with stockmen to test on a small scale various methods of reducing or eliminating loss. Where the tests showed promise, the successful

FIG. 1.—Cattle grazing on typical mountain weed meadow containing larkspur, Stanislaus National Forest.

methods were then used in actual range management. Grazing sheep on larkspur areas within cattle range has been tried out in a number of localities, many miles of fence have been constructed to keep cattle off dangerous poison areas, and there has been extensive as well as experimental eradication of larkspur.

The results of this work, though not yet complete, have changed materially the opinions of both the stockmen and the men administering the grazing lands as to the comparative efficiency of the different methods and the conditions under which a given method is practicable.

ERADICATION OF LARKSPUR BY GRUBBING.

For National Forest ranges as a whole the most effective way of eliminating loss from larkspur poisoning is to grub out the plants. This method is made practicable by the fact that larkspur grows mainly in isolated patches; on the greater portion of the range there is not enough of it to endanger the cattle. Grubbing, furthermore, appears to offer a permanent solution of the problem, while other methods which have been tried are more in the nature of temporary expedients.

Following careful experiments in 1913 and 1914 in grubbing larkspur on three selected areas in the Stanislaus National Forest eradication work was undertaken in 1915 on some 14,000 acres of cattle range in the same National Forest. The range selected is typical of high Sierra ranges, lying between 6,500 feet and 9,500 feet altitude. The areas of larkspur accessible to cattle totaled approximately 68 acres, distributed in patches varying in size from a few square yards to 10 acres, located mainly in the small weed and willow meadows, along the main drainage area, and at the heads of small streams. Of the 68 acres of larkspur grubbed out approximately 42 acres were in willows along drainage lines and around springs. The density of the willows and consequently the difficulty of eradication varied considerably. Two areas of one-half and three-tenths of an acre were selected for special study of eradication in willows. Approximately 12 acres grubbed represented areas where there was enough rock and gravel in the soil to interfere materially with grubbing operations. An area of seven-tenths of an acre was selected for special study of eradication on sites of this character. The remaining 14 acres grubbed were open-meadow and park areas where the soil was mainly a gravelly or sandy loam, carrying some rock but not enough to interfere materially with grubbing operations. A plot of one-tenth of an acre was selected for special study of eradication on such sites.

The grubbing in 1915 was done by a crew of eight inexperienced laborers under the direction of a forest officer. The results both as to cost and as to effectiveness of eradication should be applicable to similar conditions elsewhere.

The effectiveness of grubbing on the plots selected for special study is indicated by the data in Tables 1 and 2. The plots established in 1913 were reexamined and regrubbed in 1914, 1915, and 1916. Those established in 1915 were reexamined and regrubbed in 1916.

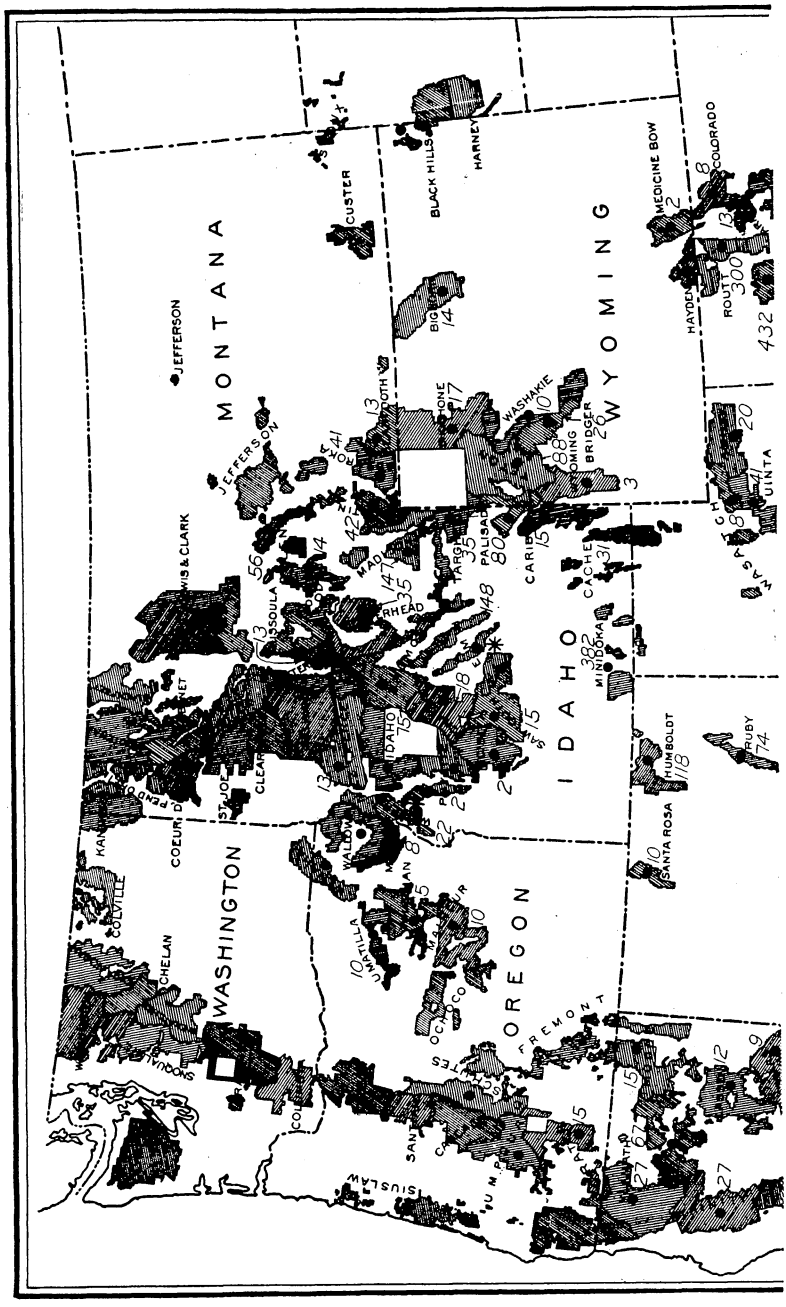
TABLE 1.—*Effectiveness of eradication by grubbing on selected plots established in 1913.*

Plot.	Area.	Habitat.	Number of plants found on plots.								Approximate percentage of plants on plots compared with original number.		
			1913		1914	1915				1916			
			On plots.	Estimated number per acre.		Seedlings.	From improperly grubbed roots missed in 1914.	Overlooked in 1913 and 1914.	Total.		1914	1915	1916
	Acres.												
1.....	0.2	Weed. Sandy, gravelly loam.	300	1,500	18	3	15	1	19	0	6	6	0
2.....	.4	.....do.....	1,500	3,750	107	0	32	0	32	0	7	2	0
3.....	.7	.....do.....	2,541	3,630	154	60	146	11	217	24	6	8	0.9

TABLE 2.—*Effectiveness of eradication by grubbing on plots established and grubbed in 1915.*

Plot.	Area.	Habitat.	Plants found on plots in 1915.				Plants found on plots in 1916.				
			Mature plants.	Immature plants.	Total.	Estimated number of plants per acre.	Overlooked in 1915.	From improperly grubbed roots.	Seedlings.	Total.	Approximate percentage.
	Acres.										
3A...	0.1	Weed. Sandy, gravelly loam.	235	112	347	3,470	1	6	14	21	6
4.....	.72	Rocky.....	955	137	1,092	1,516	3	14	12	29	2
2A...	.3	Willows.....	693	80	773	2,576	35	57	62	154	20
5.....	.5	.....do.....	529	150	679	1,358	9	6	10	25	3

On the plots established in 1913 only a little over 6 per cent of the plants were still alive the first year after eradication, while an average of 5 per cent were still surviving the second year. An examination made in July of the third season showed tnat eradication was complete on two plots. On the third plot were 24 seedlings. The seed producing most of these had undoubtedly been brought down during


MONTANA
WYOMING
IDAHO
WASHINGTON
OREGON
JEFFERSON
CUSTER
BLACK HILLS
HARNEY
MEDICINE BOW
COLORADO
ROUTT
UINTA
BIG HORN
WASHAKIE
BRIDGER
CARIBOU
CACHE
MINIDOKA
LEMHI
CLEARWATER
COEUR D'ALENE
KOOTENAI
SPOKANE
COLVILLE
CHELAN
WALLOWA
UMATILLA
MALHEUR
HUMBOLDT
SANTA ROSA
RUBY
FREMONT
SAN JUAN
ISLAND

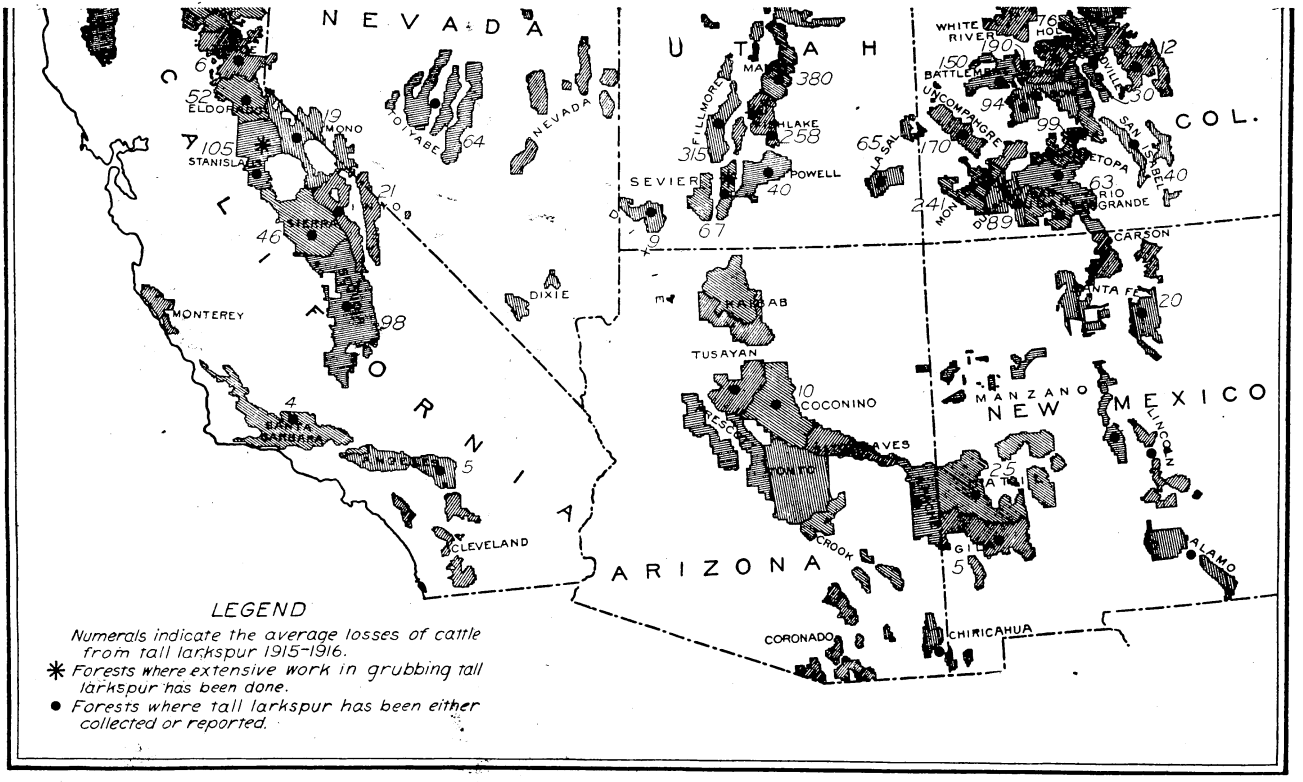


FIG. 2.—National Forests, showing distribution of tall larkspur and losses of stock from grazing it.

a heavy storm the previous season from a larkspur-infested bench located above the plot. When examined on September 27, 1916, no plants could be found on Plots 1 or 2, and only three seedlings on Plot 3. It is believed that the eradication is now complete on these areas.

It was much easier to grub out the plants on Plots 1 and 2, where the soil was loose and sandy and contained little rock or gravel, than on Plot 3, which had a moist, gravelly soil. Furthermore, the soil on Plots 1 and 2 becomes dry during the latter part of the season, while on Plot 3 it remains moist. This is a factor to be taken into account, as the grubbed plants are more likely to survive where the soil is moist than where it is dry.

The original grubbing of Plots 1, 2, and 3 was done in August and September, when the vegetation was mature, which made it difficult to find all of the plants. Besides, the first regrubbing was done toward the close of the season of 1914, when the skunk cabbage and other thrifty, leafy species growing on the plots had fallen and covered a large number of the smaller larkspur plants. The large number of plants still on the plots, especially Plot 3, in 1915, is attributed to these unfavorable conditions under which the grubbing was done.

The eradication work on the plots grubbed in 1915, except Plot 2A, was more effective than on those grubbed in 1913. The large

FIG. 3.—Tall larkspur growing on Stanislaus National Forest on area adjoining experimental Plot No. 3. Approximately 3,500 plants per acre. Cost of eradication by grubbing, $12 per acre.

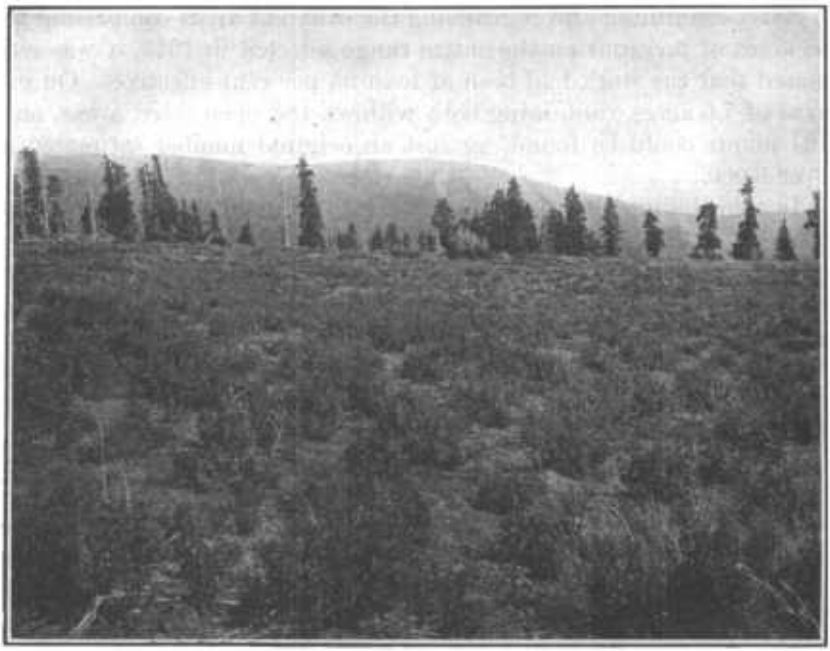


FIG. 4.—Larkspur growing on open weed type, on Fishlake National Forest. Approximately 1,500 plants per acre. Estimated cost of eradication by grubbing, $5 per acre.

number of plants found on Plot 2A is accounted for by the fact that this area was grubbed by two of the less reliable laborers without adequate supervision and, further, by the fact that it was covered with a thick, tangled growth of willows, which made grubbing very difficult. Plot 5 also was covered with willows, yet the grubbing was 97 per cent effective because the work was done carefully. The effectiveness of the work on Plot 4 was due to the grubbing being done by two reliable workmen and to the fact that this plot contained no brush. The absence of brush, however, was partly offset by the presence of considerable rock and gravel. The larger percentage of plants remaining on Plot 3A in 1916, as compared with Plots 4 and 5, was due to this plot having been grubbed by one of the less reliable men of the crew. If the grubbing had been done consistently on all the plots, it would undoubtedly have been most effective on Plot 3A, followed by Plots 4, 5, and 2A in order.

In the reexamination of these plots on September 27, 1916, two months after the second grubbing, one plant was found on Plot 3A, none on Plot 4, 15 on Plot 5, and 104 on Plot 2A. Plot 2A was regrubbed in July, 1916, just after the snow had melted and when the vegetation had barely started to grow. As a consequence, a large number of small plants were overlooked among the willows.

After examining and regrubbing the different areas comprising the 68 acres of larkspur on the entire range selected in 1915, it was estimated that the work had been at least 95 per cent effective. On one area of 7.6 acres, containing both willows and open weed areas, only 125 plants could be found, against an original number estimated at over 8,000.

In regrubbing Plots 1, 2, and 3 during 1914 and 1915, it was found that 70 per cent of the plants came from roots which had not been effectively grubbed, 25 per cent were seedlings, and 5 per cent were mature plants which had been overlooked during former grubbing operations. On Plots 2A, 3A, 4, and 5, regrubbed in 1916, 44 per cent of the plants found were seedlings, 20 per cent were plants which had been overlooked in grubbing the previous year, and 36 per cent came from roots improperly grubbed.

The plants coming from improperly grubbed roots showed lack of vigor. They usually came from parts of roots which had been split off from the main root in grubbing or from shallow lateral roots which had been cut not more than an inch from where they left the main crown. Several plants were dug, however, that came from roots which had been cut off at least 7 inches below the surface of the ground. While most of the regrubbed plants were lacking in vitality, they undoubtedly would have been able to hold their own in competition with other species and produce seed.

Extensive work in the eradication of larkspur by grubbing on other National Forest ranges shows results only slightly less effective. On the Fishlake National Forest, in Utah, larkspur was grubbed from 55 acres in September, 1915, and June, 1916. Approximately 80 per cent of the larkspur was killed by the first grubbing. In September, 1916, a careful examination of the grubbed areas showed that approximately 90 per cent of the surviving plants were growing from roots which had not been eradicated completely. A large percentage of the plants were growing from roots which had been struck a slanting stroke, cutting one side of the plant only 1 inch or less below the surface of the ground. Inefficiency from this cause can readily be eliminated by greater care in the work of eradication.

On the Sevier National Forest, in Utah, larkspur was eradicated from an area of 5 acres in July, 1916. A careful examination of the grubbed area in September, 1916, showed that approximately 90 per cent of the larkspur plants had been killed. Eighty-five per cent of the plants still growing came from roots improperly grubbed. Further examination of the work showed that where the grubbing was done after the men had had some experience 95 per cent of the plants were killed.

On the Durango National Forest, in Colorado, larkspur was grubbed from an area of 55 acres, in September, 1915, and from

40 acres in July, 1916. An examination in September showed that approximately 75 per cent of the plants had been killed. This low efficiency was due to the fact that the vegetation at the time the grubbing was done was very rank and to a considerable extent had fallen down or been trampled down, thereby making it difficult to locate the smaller larkspur plants. The experience gained in doing the grubbing in 1915 was of material advantage in connection with the work done in 1916, and it is estimated that the 1916 work resulted in 90 per cent of the larkspur plants being eradicated.

It is believed that at least 95 per cent of the plants should be killed by the first grubbing, and that in the practical application of this method one regrubbing, one year after the first grubbing, should be sufficient. A few plants may escape eradication under this plan, and others may originate from seed, but the total number will not be sufficient to cause loss of cattle from poison nor to justify the expense of a third examination and regrubbing.

Work 95 per cent effective will not necessarily cost any more per acre than work 85 per cent effective. Care must be exercised, however, to see that each plant is grubbed properly and that small plants are not overlooked. Success can be attained largely by employing reliable workers under proper supervision, especially when the work is being started, and by doing the work early in the season, when the larkspur plants show up prominently.

COST OF GRUBBING.

The cost of eradication per unit area varies considerably, depending upon the number of larkspur plants and upon the habitat. The cost of grubbing the Stanislaus experimental plots is given in Table 3.

TABLE 3.—*Cost of eradicating tall larkspur on experimental plots, Stanislaus National Forest.*

Plot.	Habitat.	Area.	Number of larkspur plants on plots at first grubbing.	Cost of eradication.	Estimated number of larkspur plants per acre.	Estimated cost of eradication per acre.
		Acres.				
1	Weed. Sandy, gravelly loam.	0.2	300	$2.50	1,500	$12.50
2	....do	.4	1,500	7.50	3,750	18.75
3	....do	.7	2,541	12.50	3,630	17.85
3-A	....do	.1	347	1.55	3,470	15.50
4	Rocky	.72	1,092	13.75	1,516	19.10
2-A	Willows	.3	773	7.50	2,576	25.00
5	....do	.5	679	6.25	1,358	12.50
Average					2,547	17.31

Plots 1, 2, 3, and 3A have approximately the same soil and vegetation. They are located in an open weed area having a sandy

to gravelly loam soil of sufficient depth to permit the use of a mattock in grubbing. The cost per acre for eradication on these plots varies in the main with the number of larkspur plants per acre, though not in direct proportion. The work on these first plots was experimental, and the primary object was effective eradication rather than securing a knowledge of comparative costs. Consequently, the rate of work was not necessarily the same. The comparison, however, serves to emphasize the fact that in estimating the cost of any piece of eradication work, the number of plants per acre must be taken into account.

Plot 4 is in a park area, on a moist, rocky, gravelly loam soil. It was hardly possible to stick a pick into the ground without striking rock. The estimated cost for grubbing is approximately 2½ times greater per plant under such conditions than on the deep, sandy to gravelly loam soils of Plots 1, 2, 3 and 3A. Figured per acre, however, the cost becomes considerably less, for usually there is a much smaller number of plants per acre on rocky soils than on the better sites.

Plots 2A and 5 are located in willows. On Plot 2A it was necessary to cut out about half of the willows, roots and all, before the larkspur could be effectively grubbed. The willows on Plot 5 were dense but straight; consequently, less willow cutting was necessary than on Plot 2A. The cost of eradication in the willows is approximately double the cost per plant on the open areas having a sandy to gravelly loam soil, and approximately one-fifth less than eradication on rocky soil, such as Plot 4. The extra cost for chopping out willows is almost offset, however, by the smaller number of larkspur plants per acre, usually about one-third less than on good soils in the open; by the character of the soil, usually of a fine texture free from rocks; and by the comparative shallowness of the larkspur roots.

The costs given in Table 3 are considerably above the average for extensive eradication where experimental data, involving counts of plants and care in following plot lines, are not collected. Further, experimental plots were selected as more difficult than the average.

In eradicating the 68 acres of larkspur from the entire range surrounding the special plots, the average cost of grubbing in the open was $9.81 per acre, and in willows $10.26 per acre, with a general average of $10.10 per acre. The 68 acres contained approximately one-third less larkspur plants than the experimental plots.

The cost of extensive grubbing on other National Forests was less than that for the work on the Stanislaus, as shown by Table 4. The work was also slightly less effective.

TABLE 4.—*Cost of extensive larkspur eradication.*

Forest.	Acreage grubbed.	Total cost of grubbing.	Cost per acre.	Average number of plants per acre.
Fishlake	55	$228.00	$4.15	1,000
Sevier	5	21.50	4.30	1,500
Durango	95	350.00	3.65	.....

It is believed that from $3.65 to $4.15 per acre represents a conservative average cost of eradicating larkspur on areas relatively free from rocks, willows, and brush.

The average cost of $10.10 per acre for the Stanislaus work undoubtedly represents a maximum cost for any eradication work, because all conditions making grubbing difficult and costly were encountered. This figure, therefore, is a conservative one to use in estimating the expense of grubbing in all willow or rocky areas.

The cost of regrubbing the experimental plots was about one-tenth of the cost of the original grubbing. In regrubbing larger areas the cost should not exceed $1 per acre, and in most cases should be about half that.

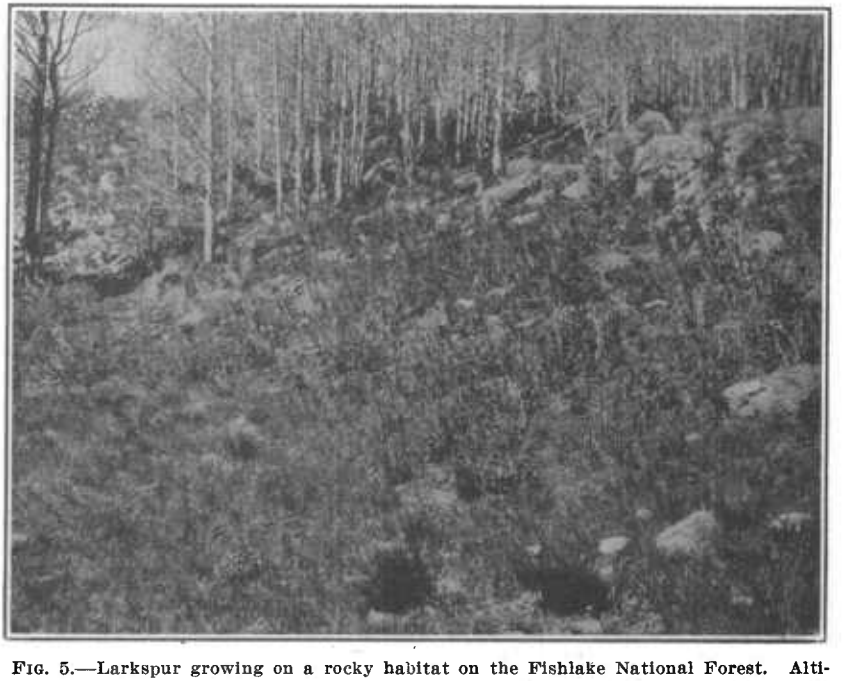


FIG. 5.—Larkspur growing on a rocky habitat on the Fishlake National Forest. Altitude 10,100 feet. Approximately 1,500 plants per acre. Estimated cost of eradication by grubbing, $10 per acre.

PRACTICABILITY OF GRUBBING.

Judged alone, the average cost of $10.10 per acre for eradication on the Stanislaus National Forest, or even the $3.65 per acre for eradication on the Durango National Forest, seems too high to be good business. Whether eradication is good business, however, depends upon other things besides the cost; it depends upon the relation between the acreage of larkspur and the cost of eradicating it, the number of cattle the whole range will carry if freed from larkspur, the average money value of the cattle annually lost from larkspur poisoning before eradication, and the reduction in cost of handling the cattle as a result of eliminating the larkspur.

In the Stanislaus Forest, for example, the eradication of approximately 68 acres of larkspur at a total cost for the first and second grubbings of $844.31 saved an annual loss in cattle of 34 head, valued at from $1,200 to $2,000.

On the Sevier National Forest the grubbing of 5 acres of larkspur at a cost of $21.50 cleared an area upon which 15 head of cattle died of larkspur poisoning in 1915, and 9 head prior to the work of grubbing in July, 1916. There was no loss after the grubbing was done. The saving in cattle during 1916, after grubbing in July,

FIG. 6.—Two-year-old heifer poisoned by tall larkspur. The poison was secured from the small patch at the upper left-hand side of the photograph. The animal had traveled about 50 yards from the larkspur patch.

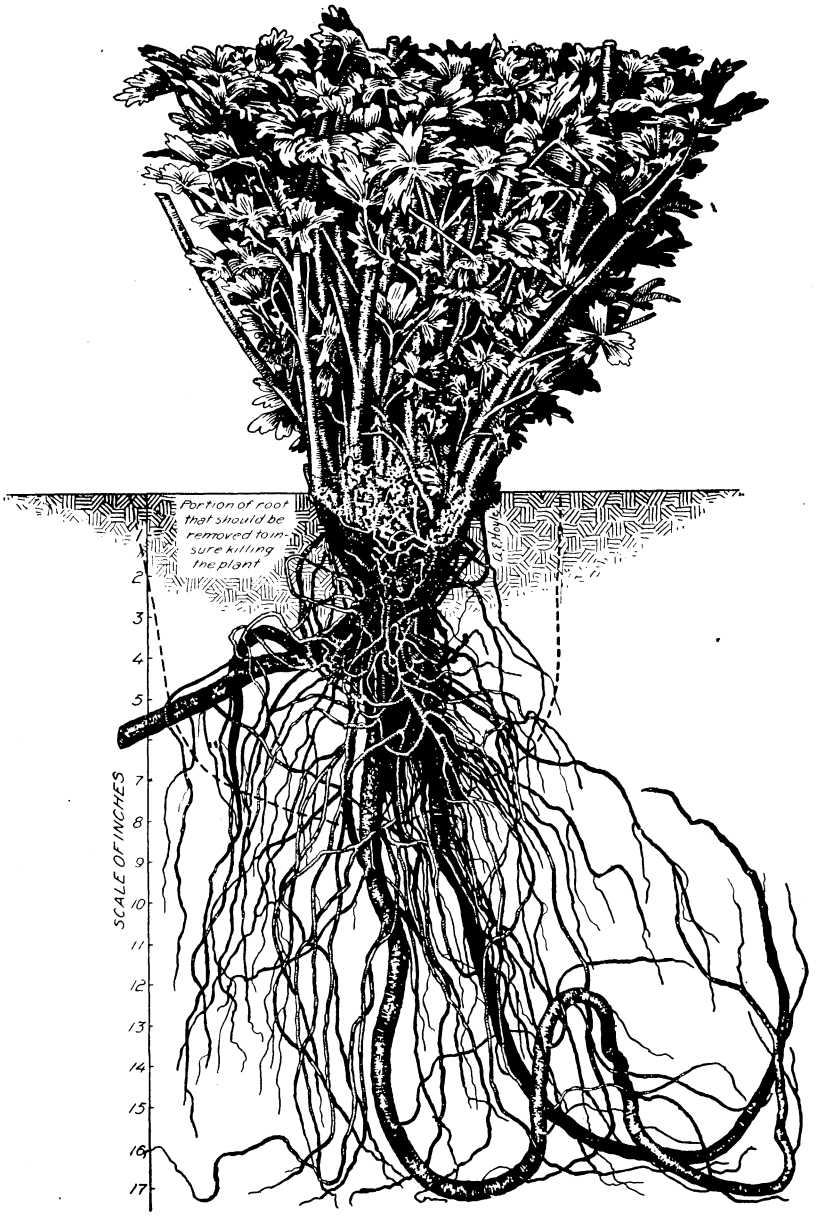


FIG. 7.—Larkspur plant showing root system. The dotted line indicates the portion of the root which should be removed in grubbing.

amounted to six head valued at $250. It is estimated that $5 expended in 1917 for regrubbing will finish the work.

On the Fishlake National Forest the grubbing of 55 acres of larkspur, at a cost of $228, only partly completed the project. Twenty-nine acres remain to be grubbed, at an estimated cost of $145. The cost of going over the entire 84 acres a second time will be $75, making a total cost of about $450 for eradication. During 1915, 23 head of cattle, valued at $1,200, died from larkspur poisoning.

On the Durango National Forest the annual losses of stock from larkspur poisoning on the ranges from which the larkspur was grubbed in 1915 and 1916 exceeded $1,000 in value. The cost of grubbing out the larkspur was $350.

During the season of 1916 four larkspur-infested ranges on the Fishlake National Forest, one range on the Palisade, one on the Ruby, and one on the Sevier were studied to determine the best means of remedying the trouble. All larkspur areas were mapped, the acreage determined, and the number of plants per acre and the cost of eradication carefully estimated. On the Fishlake it was found that grubbing would be the most effective and practical method on three of the ranges. In each of these cases the poison areas could be grubbed for a sum ranging from $700 to $1,500 less than that represented by the annual loss in cattle. On the fourth range a combination of grubbing and fencing was recommended. This range was found to have 920 acres of larkspur, responsible for an average annual loss of 30 head of cattle, valued at $1,500. Ninety per cent of the losses occur on approximately 200 acres which can be grubbed for approximately $900, or $450 less than the value of the stock lost annually. The average annual loss on the remaining 720 acres amounts to only three head, valued at $150, while the estimated cost of eradication is $3,500. A drift fence of approximately four miles, estimated to cost $500, will not only keep the cattle from the poison on this 720 acres, but in addition will improve range management as a whole on the range unit involved. Consequently the recommendation in this case is to grub the larkspur from the 200 acres and construct the fence to protect against loss on the remaining 720 acres—a plan clearly practical as a business proposition.

On the Ruby National Forest, in eastern Nevada, an area of approximately 10 acres of larkspur causes an average annual loss of 10 head of cattle. The cost of grubbing out this larkspur is estimated at $60, less than one-eighth of the value of the cattle lost annually.

During the season of 1916 at least 60 head of cattle, valued at about $3,000, died of larkspur poisoning on the range examined on

the Sevier National Forest. Approximately 63 acres of larkspur was responsible for this loss. It was estimated that this can be grubbed out for about $400. This range supports 1,600 head of cattle. The eradication work, therefore, can be done for about 25 cents per head, or a total cost amounting to less than one-seventh the value of the cattle lost in 1916.

On the Grand Canyon cattle range of the Palisade National Forest, during the season of 1915, about 65 head were lost out of the 660 cattle grazed. In 1916 only 320 animals were grazed on the allotment, principally on account of previous excessive losses, which caused several users to sell their stock rather than have them go back on the range. The larkspur grows in scattered stands in isolated areas, and the entire range can be grubbed for about $1,200. If this is done, it will make possible the grazing of at least 1,000 head of cattle on this range without loss from poisoning. In addition, considerable money which is now expended for employing riders to keep the stock off the dangerous areas would be saved. On the basis of the carrying capacity of the range, the grubbing work can be done for $1.20 per head.

METHOD OF GRUBBING.

DEPTH.

To grub tall larkspur effectively, the main part of the root system, including all of the main roots before they divide into small lateral roots, should be removed. The depth of grubbing necessary to accomplish this depends upon the size of the root. Where the roots average about 2 feet in length, grubbing should be done to a depth of 8 inches. Where the roots do not average more than 1½ feet in length, grubbing to a depth of 6 inches is usually sufficient. The very large bunches frequently have large shallow lateral roots. Care should be taken to remove these to at least 4 inches from where they leave the main root. A great number of the plants which survive the first grubbing sprout from these lateral roots that have not been grubbed far enough from the main root. (See fig. 7.)

TOOLS.

A pick with one end drawn out to a chisel form about 2 inches wide is probably the best tool for use in all kinds of soil. A shovel is unsatisfactory. A mattock is good in sandy soil, but can not be used advantageously in rocky soil. Grubbing hoes are not satisfactory because the blade is too short to remove enough of the roots to kill the plants unless extra care and time are taken.

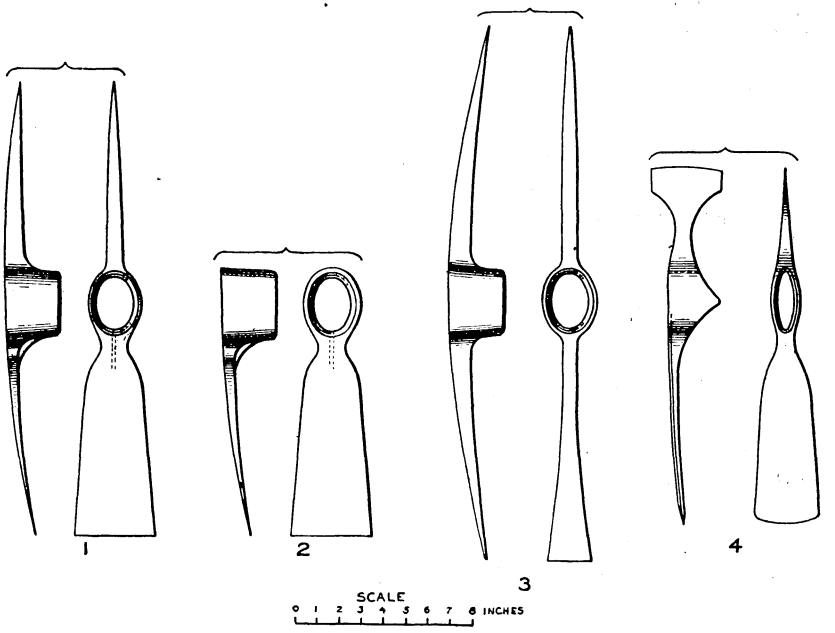


FIG. 8.—Tools used in grubbing larkspur.—1. Pick-mattock for use in rocky soil. 2. Special grubbing hoe for use in loam soils. 3. Special pick used on Stanislaus National Forest. 4. Special mattock used on Fishlake National Forest.

The chisel end of the pick is used in fine soils to grub out the roots; while the pointed end is very useful in loosening the soil in gravelly or rocky areas, after which the plant can be removed with the chisel end. Sometimes the chisel end may be too narrow to remove all of the main root of the large plants with one stroke, in which case extra care is necessary to prevent small portions being left in the soil.

A combination pick-mattock is a good tool to use in rocky soils. It has a pick end for loosening the gravel or rocks and a long wide blade for removing the roots. In soils which do not have enough rock or gravel to interfere with grubbing a mattock with the spur cut off has proved to be very good.

On the Fishlake National Forest in Utah a special tool, made by welding enough material on a light pick to make a blade 9 by 3½ inches and shaping the other end into a spur similar to a mattock, was used. This tool weighed about 3½ pounds and was very effective in loamy soils containing little or no gravel.

A mattock with the spur cut off to make it lighter and the blade drawn out to about 9 inches in length and a specially made grubbing hoe having a blade of similar length are best for use in loamy soils. In rocky or gravelly soils either the pick with one end flattened, as shown in figure 4, or the combination pick-mattock should be used. Unless the soil is very rocky the pick-mattock is better than the pick.

TIME OF GRUBBING.

The best time to grub out tall larkspur is early in the season, as soon as the plants have made sufficient growth to be recognized readily.[1] This time varies somewhat in different localities and with altitude. On most areas the larkspur is large enough to be readily recognized one week after growth has started.

DISPOSAL OF GRUBBED PLANTS.

Probably the best way to dispose of grubbed plants is to scatter them, after shaking most of the dirt from their roots. After being exposed to the sun for one week, the scattered plants dry out so completely that stock will not eat them. It is not a good plan to pile the grubbed plants with the idea of burning them when they dry out. The plants not directly exposed to the sun do not dry out within a reasonable time and are likely to start new growth. This was found to be the case on the Stanislaus National Forest in 1913, even when care was taken to place the roots as far as possible on the outside of the piles. Moreover, to grub the plants and pile them requires one-third more time than to grub and scatter them.

REVEGETATION OF GRUBBED AREAS.

Larkspur usually grows in soils adapted to other range plants; for that reason the grubbed areas are soon normally revegetated by the associated native species. Comparison of the experimental areas established on the Stanislaus National Forest in 1913 with similar situations where the larkspur had not been disturbed, showed that the native vegetation had replaced the larkspur in two years. The

[1] Tall larkspur makes a thrifty, vigorous growth from the time it starts until it reaches its maximum height, which in some plants is 6 feet. Observations made in 1915 on two average-sized plants of larkspur (*Delphinium glaucum*) on the Stanislaus National Forest, in east central California, showed the following growth:

Height of stalks on—	July 14.	July 26.	August 3.
Plant No. 1	2 feet 2 inches.	3 feet	3 feet 5 inches.
Plant No. 2	1 foot 11 inches.	2 feet 10 inches.	3 feet 2 inches.

Number of stalks on—	July 14.	July 26.	August 3.
Plant No. 1	20	56	60
Plant No. 2	17	47	56

These plants were growing on an open weed area in a moist, sandy loam soil, at an altitude of 7,800 feet. They started growth about July 4; flower buds were first noticed July 29, and flowers were produced August 10. It is estimated that the seed would have been disseminated about September 1.

When the larkspur plants start growth they seldom have more than two or three stalks, but as they mature the number increases, the new stalks coming from near the top of the crown. Sixty stalks was the maximum number found on any one plant. The number varied greatly, depending upon the age and vigor of the plant.

revegetation of a large percentage of the patches can be accelerated and their grazing capacity possibly increased by seeding them to cultivated forage species. In the more moist situations timothy and Kentucky bluegrass would be the most satisfactory species to use in reseeding. In the drier situations smooth brome-grass and timothy are suggested. Details in regard to how artificial reseeding can be successfully accomplished are given in Department Bulletin No. 4.

SHEEP GRAZING OF LARKSPUR AREAS ON CATTLE RANGES.

Since sheep are not poisoned by larkspur, the problem may sometimes be solved by running a band of sheep over the poison areas early in the season before the cattle reach them. The success of this method depends largely on whether the sheep will eat the larkspur, whether sheep are available to graze the infested area at the proper time, and whether the infested areas furnish sufficient forage to justify trailing sheep to them.

Many National Forest users prefer to raise cattle rather than sheep. This will be true in many places until the sheep industry is placed more on a farm basis than it is at present and the large bands handled under present range conditions give way to small numbers of sheep on farms. It is frequently not possible, therefore, to transfer large areas of larkspur-infested range from cattle to sheep. Experimental tests have been made, however, in grazing a few sheep on larkspur-infested cattle ranges.

On a cattle range adjoining a sheep range within the Mono National Forest in Nevada a band of sheep were run with the cattle on the range throughout the season. The larkspur poison areas were grazed closely by the sheep early in the season before the cattle reached them. The sheep were then grazed on portions of the range which the cattle did not ordinarily use. In case there was a second growth of larkspur sufficient to cause probable loss of cattle on any of the infested areas the sheep were grazed over these areas a second time. The larkspur in this case was grazed by the sheep in preference to many other forage species. As a result, the forage on these areas which previously had poisoned cattle was transformed into mutton. Furthermore, small areas of range previously unused by the cattle were utilized by the sheep.

A somewhat similar plan was tried for two years on the Ruby National Forest in Nevada. In two small canyons on separate cattle allotments an annual loss from larkspur poisoning amounted to approximately $800 worth of cattle. Each of these larkspur-infested areas contained about three weeks' feed for a small band of sheep.

The plan adopted was to place one band of sheep on each area before the cattle drifted to it. The first year the sheep did not graze

larkspur as readily as they did other forage species. By close herding on the poison areas, however, all of the larkspur was either grazed or trampled down before the cattle reached it. In the second year of the test difficulty was encountered in securing sheep, for the reason that the cattle range in question was some distance from the regular sheep range, and the larkspur-infested areas to be grazed were not large enough to justify removing the sheep from their accustomed range to the cattle range. This difficulty caused delay in grazing the larkspur-infested areas and as a result four head of cattle were poisoned before these areas were grazed by the sheep. Further, the sheep were not close-herded on the larkspur patches long enough to graze or destroy all of the larkspur, so that there was still danger of cattle being poisoned after the sheep were removed.

This case is typical of the difficulty that lies in the way of controlling loss of cattle from larkspur by grazing the infested areas with sheep. Such areas are often at a considerable distance from regular sheep range and are not large enough and are not properly distributed to accommodate the average-sized band of range sheep for the summer season. To supplement the forage on the larkspur-infested areas by additional portions of the cattle range not infested would make it necessary to reduce the number of cattle below that desired and needed by the cattle owners.

On the Fishlake National Forest in Utah sheep grazing of infested areas proved impracticable. The sheep grazed nearly all of the other forage plants present in preference to the larkspur. Thus by reducing the amount of forage palatable to cattle and eating only a portion of the larkspur the sheep grazing had a tendency to increase the loss of cattle from larkspur poisoning rather than to reduce it. The only effective way to reduce the loss under such conditions would be to hold the sheep on the infested areas until they are forced to eat or trample down all of the larkspur. This would be both detrimental to the sheep and destructive to the range. It would mean excessive trampling and in many cases would lead to erosion.

FENCING AS A PROTECTION AGAINST LOSS.

Drift fences should be used as a means of controlling losses from tall larkspur only where the cost of eradication is prohibitive, or on areas where "sheeping off" the larkspur is not practicable, or where the fence will have additional value in the management of the stock and range.

The main objections to the use of drift fences are that they do not offer a permanent remedy for the problem, and that unless horses or sheep are available to place on the fenced areas considerable feed is wasted. There is also a chance that the stock will get

through the fences at the dangerous time and eat the larkspur. Moreover the fences must be kept in good repair, which, at the high altitudes, means considerable expense; and they must be rebuilt about once every 10 years.

SUMMARY.

1. Grubbing out the plants is the most feasible method of preventing loss of cattle from tall larkspur poisoning. Undoubtedly on a small proportion of the ranges infested with tall larkspur this method will not be applicable. On a larger proportion, however, results will be just as satisfactory as those reported here.

2. The first grubbing costs from $3.65 to $10.10 per acre, the cost depending upon (1) the number of plants per acre, (2) the texture of the soil, and (3) whether or not the plants are growing in the open or in willows or other brush. The cost of the second grubbing should not exceed $1 per acre.

3. Extensive eradication on four Forests has been done at a cost of less than one-half the value of the cattle saved annually. A careful examination of six additional ranges on four different Forests shows that the larkspur can be grubbed out at a cost amounting to approximately two-thirds the market value of the cattle lost annually from larkspur poisoning on these ranges. On one range a combination of grubbing and construction of fence will be necessary to eliminate loss.

4. Tall larkspur can be eradicated by grubbing out the main roots at a depth of from 6 to 8 inches below the surface, the depth which is necessary depending upon the size of the root. An average of 93 per cent of the plants in the experimental work and of from 80 to 95 per cent in extensive work were killed by the first grubbing. By a regrubbing of the area one year after the first grubbing practically all of the larkspur plants are killed. A very small percentage may be overlooked, and a few may come in from seed, but there will not be enough larkspur to cause poisoning of cattle or to justify the expense of a third grubbing.

5. For grubbing, a mattock with the spur cut off and the blade drawn out to about 9 inches in length, or a special grubbing hoe having a similar blade, is recommended for use in loam soils. For rocky soils, a pick with one end flattened to a chisel shape, 2 inches wide, or a combination pick-mattock having a 9-inch blade, is recommended.

6. The use of sheep to graze off larkspur-infested cattle range has a limited application. Its success depends (1) on the palatability of the larkspur, (2) the availability of sheep to graze the infested area at the proper time, and (3) whether the infested areas furnish sufficient forage to justify trailing sheep to them.

7. Fencing should be used for controlling losses from larkspur poisoning only where the acreage of larkspur is too great for grubbing to be feasible, or where the fence will serve other administrative needs in the handling of stock on the range as well as preventing loss from poison. As a rule, the initial cost for fencing will be greater than the cost of eradication by grubbing; the cost of maintaining fences in shape so that the cattle will not get through them is considerable at the high altitudes where they would be built for this purpose; they will have to be rebuilt in approximately 10 years, thus affording a temporary solution only; and unless horses or sheep are available to graze the areas from which cattle are excluded by the fences, a good deal of forage will be wasted annually through nonuse. Eradication by grubbing is free from these objections.

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